US005300389A

United States Patent [19]

Law et al.

[11] Patent Number: 5,300,389
[45] Date of Patent: Apr. 5, 1994

[54] **TONER COMPOSITIONS WITH HALOGENATED ALUMINUM SALICYLIC ACID COMPLEX CHARGE ENHANCING ADDITIVES**

[75] Inventors: **Kock-Yee Law**, Penfield; **Ihor W. Tarnawskyj**, Webster, both of N.Y.

[73] Assignee: **Xerox Corporation**, Stamford, Conn.

[21] Appl. No.: **978,571**

[22] Filed: **Nov. 19, 1992**

[51] **Int. Cl.**[5] **G03G 9/097**
[52] **U.S. Cl.** **430/110**
[58] **Field of Search** 430/110

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,206,064 6/1980 Kiuchi et al. 430/106
4,298,672 11/1981 Lu 430/108
4,378,420 3/1983 Gruber et al. 430/120
4,404,271 9/1983 Kawagishi et al. 430/110
4,411,974 10/1983 Lu et al. 430/106
4,656,112 4/1987 Kawagishi et al. 430/110
4,762,763 8/1988 Nomura et al. 430/110
4,767,688 8/1988 Hashimoto et al. 430/110
4,845,003 7/1989 Kiriu et al. 430/110
5,232,809 8/1993 Anzai et al. 430/110

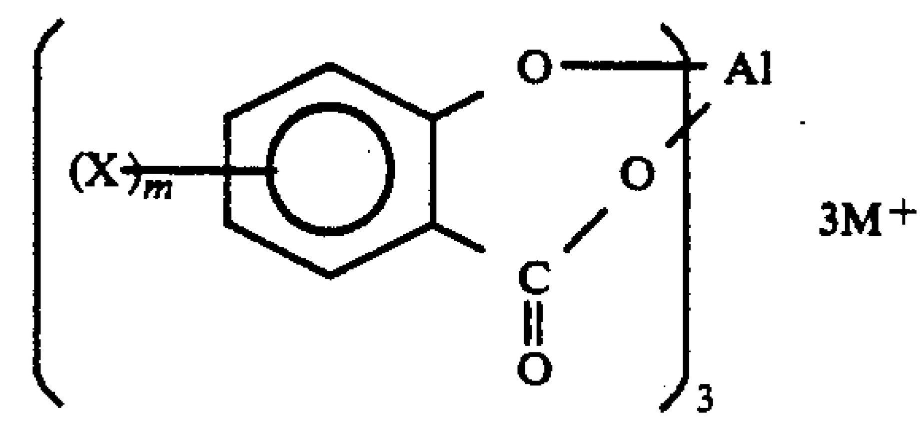
FOREIGN PATENT DOCUMENTS

212851 9/1986 Japan 430/110
306253 12/1990 Japan 430/110

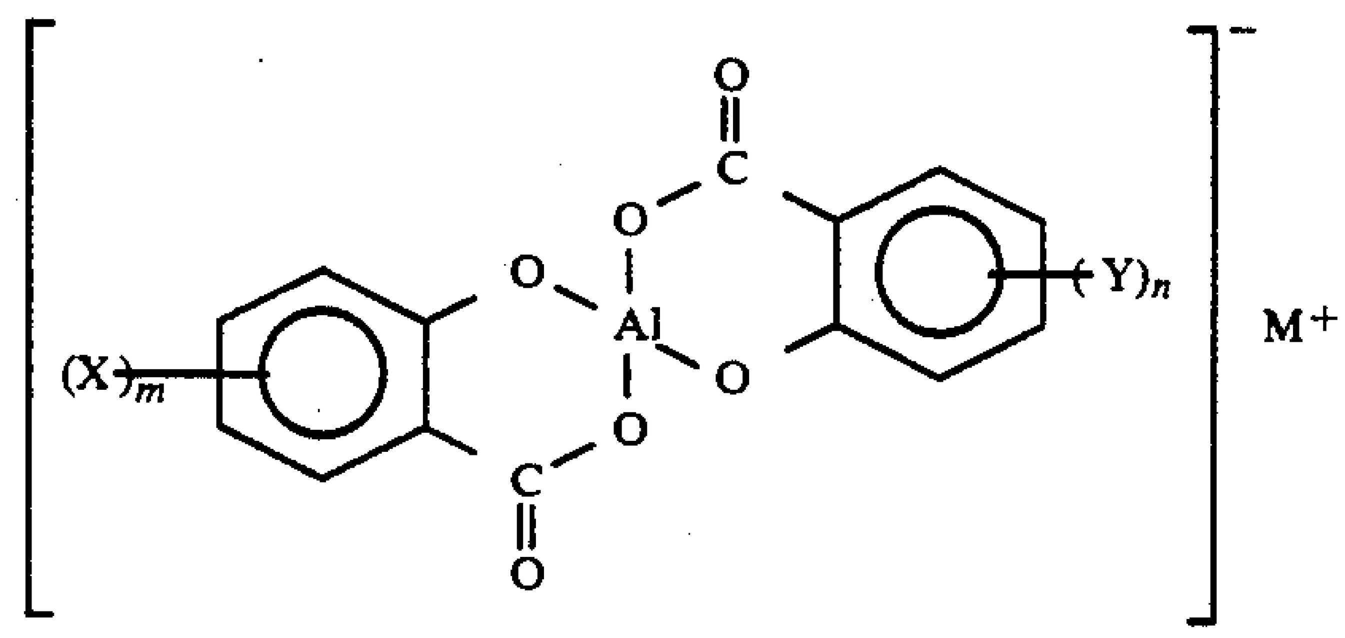
Primary Examiner—Roland Martin
Attorney, Agent, or Firm—E. O. Palazzo

[57] **ABSTRACT**

A negatively charged toner composition comprised of resin particles, pigment particles, optional surface additives, and a halogenated aluminum salicylic acid complex charge enhancing additive of the following formulas



or



wherein M is hydrogen, an alkali metal, an alkaline earth metal, NH_4, or NR_4 wherein R is alkyl; X and Y are independently selected from the group consisting of iodide, chloride and bromide, and n and m are the numbers 1 or 2.

20 Claims, No Drawings

TONER COMPOSITIONS WITH HALOGENATED ALUMINUM SALICYLIC ACID COMPLEX CHARGE ENHANCING ADDITIVES

BACKGROUND OF THE INVENTION

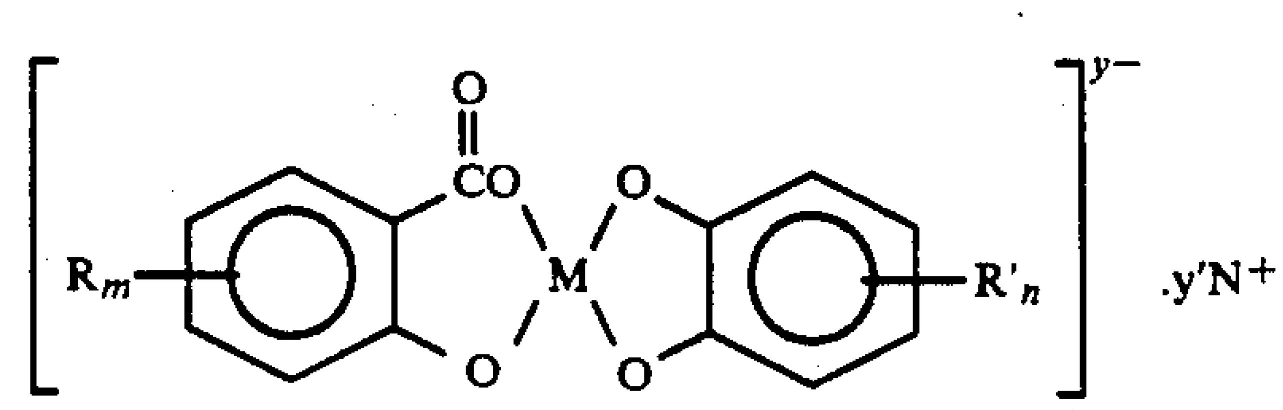
The invention is generally directed to toner and developer compositions, and more specifically, the present invention is directed to developer and toner compositions containing charge enhancing additives, which impart or assist in imparting a negative charge to the toner particles and enable toners with rapid triboelectric charging characteristics. In one embodiment, there are provided in accordance with the present invention toner compositions comprised of resin particles, pigment particles and certain charge enhancing additives. In embodiments, the present invention is directed to toners with halogenated aluminum salicylic acid complex charge enhancing additives. The aforementioned charge additives in embodiments of the present invention can enable, for example, toners with rapid triboelectric charging characteristics, extended developer life, stable triboelectrical properties irrespective of substantial changes in environmental conditions, and high image print quality with substantially no background deposits. Also, the aforementioned toner compositions usually contain a colorant component comprised of, for example, carbon black, magnetites, or mixtures thereof, color pigments or dyes with cyan, magenta, yellow, blue, green, red, brown, or mixtures thereof thereby providing for the development and generation of black and/or colored images. The toner and developer compositions of the present invention can be selected for electrophotographic, especially xerographic, imaging and printing processes, including color processes.

Toners with negative charge additives are known, reference for example U.S. Pat. Nos. 4,411,974 and 4,206,064, the disclosures of which are totally incorporated herein by reference. The '974 patent discloses negatively charged toner compositions comprised of resins, pigment particles, and as a charge enhancing additive ortho-halophenyl carboxylic acids. Similarly, there are disclosed in the '064 patent toner compositions with certain chromium, cobalt, and nickel complexes as negative charge enhancing additives. In U.S. Pat. No. 4,845,003, there are illustrated negatively charged toners with certain aluminum salt charge additives. More specifically, this patent discloses, for example, as charge additives alkyl(tertiary-butyl) aluminum with two or three hydroxybenzoic acid ligands bonded to a central aluminum ion. While these charge additives may have the capability of imparting effective negative triboelectric charges to toner particles, they are generally not efficient in promoting the rate of triboelectric charging of toner particles, are costly, and cause melt index temperature changes during the toner preparation, especially when a polyester is selected as a toner resin, disadvantages avoided or minimized with the toners of the present invention. A fast rate of triboelectric charging is particularly crucial for high speed xerographic machines since, for example, these machines consume toner rapidly, and fresh toner has to be constantly added. The added uncharged toners, therefore, must charge up to their equilibrium triboelectric charge level rapidly to ensure no interruption in the xerographic imaging or printing operation. Another disadvantage with these charge additives is their thermal instability, that is they often break down during the thermal extrusion process of the toner manufacturing cycle. Most or many of these and other disadvantages are eliminated, or substantially eliminated with the toners containing the charge additives of the present invention.

Also of interest are U.S. Pat. Nos. 4,404,271; 4,656,112; 4,762,763; 4,206,064; 4,767,688; 4,378,420, and 4,433,040. Two of the charge additives of the aforementioned prior art, namely 1:2 boron 3,5-dl-tertiary-butylsalicylic acid complex, or 1:2 boron 3,5-dlbutylsalicylic acid complex, when added to toner compositions have inferior characteristics such as tribocharging characteristics as compared to the toners of the present invention in embodiments.

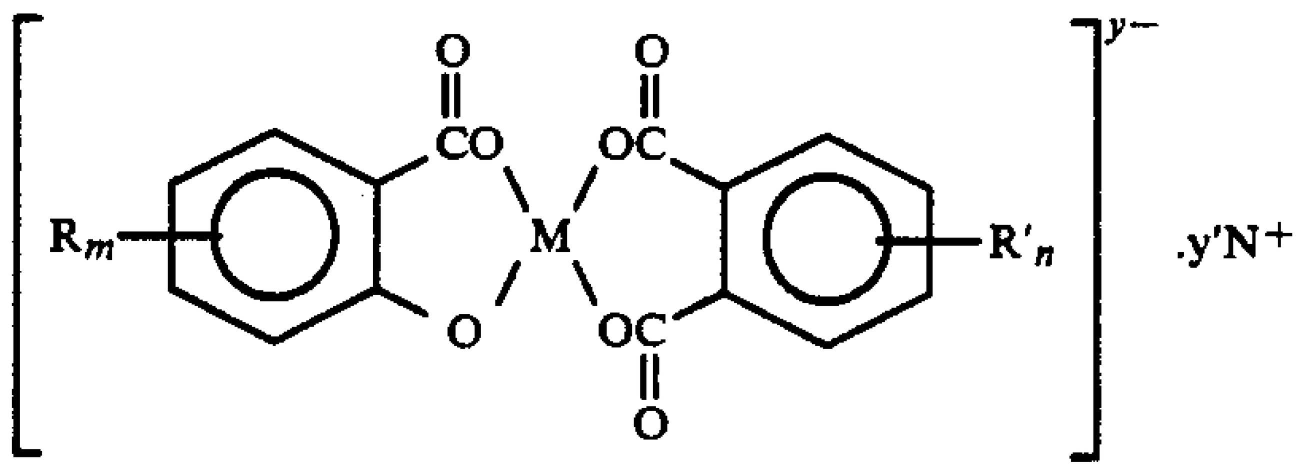
Developer compositions with charge enhancing additives, which impart a positive charge to the toner particles, are also well known. Thus, for example, there is described in U.S. Pat. No. 3,893,935 the use of quaternary ammonium salts as charge control agents for electrostatic toner compositions; U.S. Pat. No. 1,221,856 which discloses electrophotographic toners containing resin compatible quaternary ammonium compounds in which at least two R radicals are hydrocarbons having from 8 to about 22 carbon atoms, and each other R is a hydrogen or hydrocarbon radical with from 1 to about 8 carbon atoms, and A is an anion, for example sulfate, sulfonate, nitrate, borate, chlorate, and the halogens such as iodide, chloride and bromide, reference the Abstract of the Disclosure and column 3; a similar teaching is presented in U.S. Pat. No. 4,312,933 which is a division of U.S. Pat. No. 4,291,111; similar teachings are presented in U.S. Pat. No. 4,291,112 wherein A is an anion including, for example, sulfate, sulfonate, nitrate, borate, chlorate, and the halogens; U.S. Pat. No. 4,338,390, the disclosure of which is totally incorporated herein by reference, develops developer compositions containing as charge enhancing additives organic sulfate and sulfonates, which additives can impart a positive charge to the toner composition; U.S. Pat. No. 4,298,672, the disclosure of which is totally incorporated herein by reference, develops positively charged toner compositions with resins and pigment particles, and as charge enhancing additives alkyl pyridinium compounds.

Illustrated in copending patent application U.S. patent application Ser. No. 894,688 are toner compositions comprised of polymer resins, colorants comprised of color pigment particles or dye molecules, and certain metal complex charge additives derived from the reaction of a mixture of a hydroxybenzoic acid and a base with a metal ion in the presence of an excess of a hydroxyphenol. More specifically, this copending application illustrates a negatively charged toner composition comprised of polymer, colorant, optional surface additives, and a metal complex charge enhancing additive of the following formula

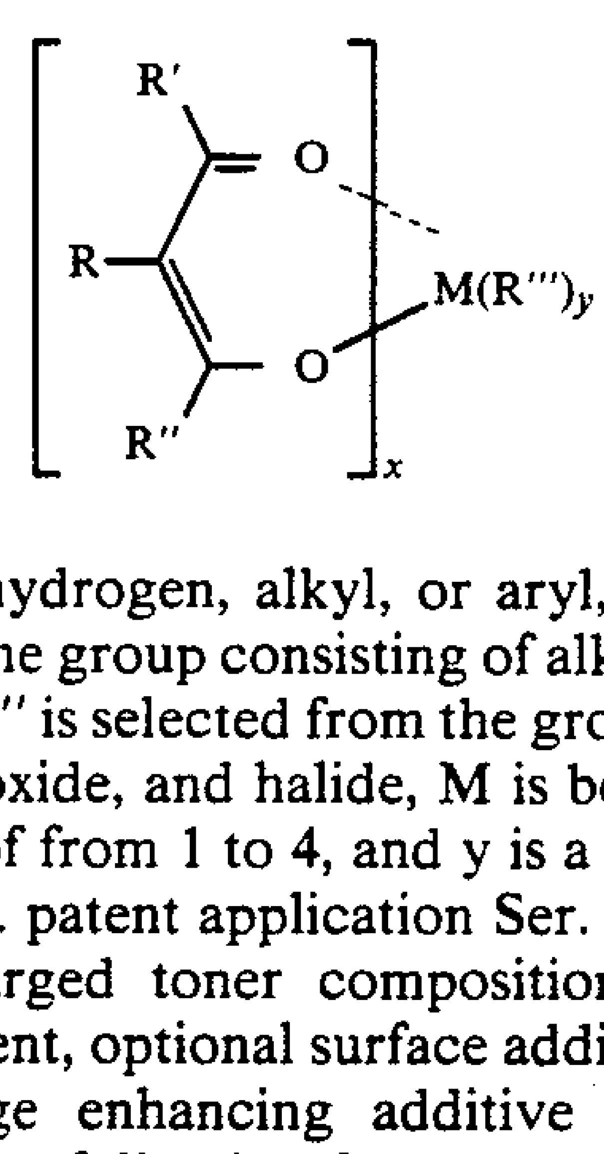


where M is a metal; N+is a cation; R and R' are alkyl, alkoxy, aryloxy, halogen, carbonyl, amino, nitro, or mixtures thereof; m and n are the number of R substituents ranging from 0 to 3; y−is the magnitude of the negative charge of the anion; and y' represents the number of cations.

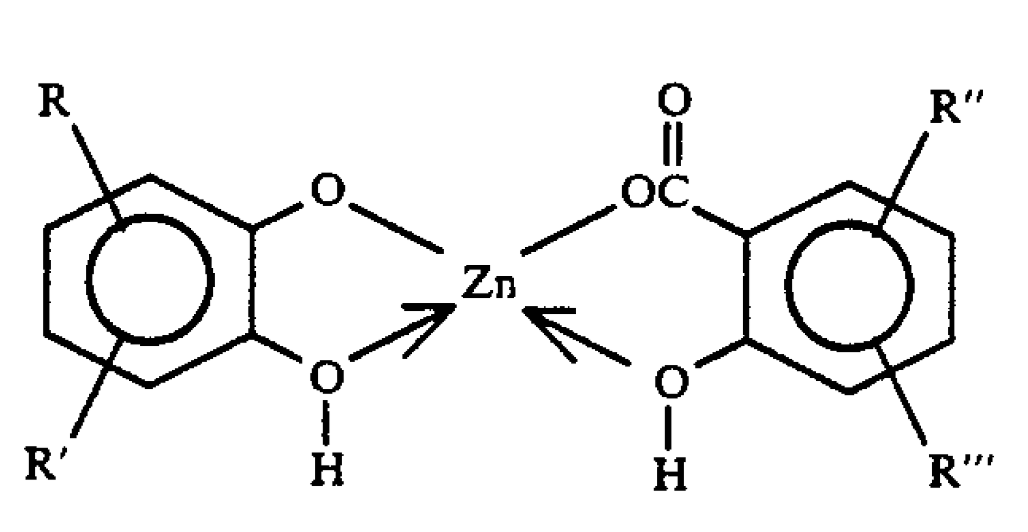
Illustrated in copending patent applications U.S. patent application Ser. No. 894,690 is a negatively charged toner composition comprised of a polymer or polymers, pigment, and a metal complex charge enhancing additive as essentially represented by the following formula

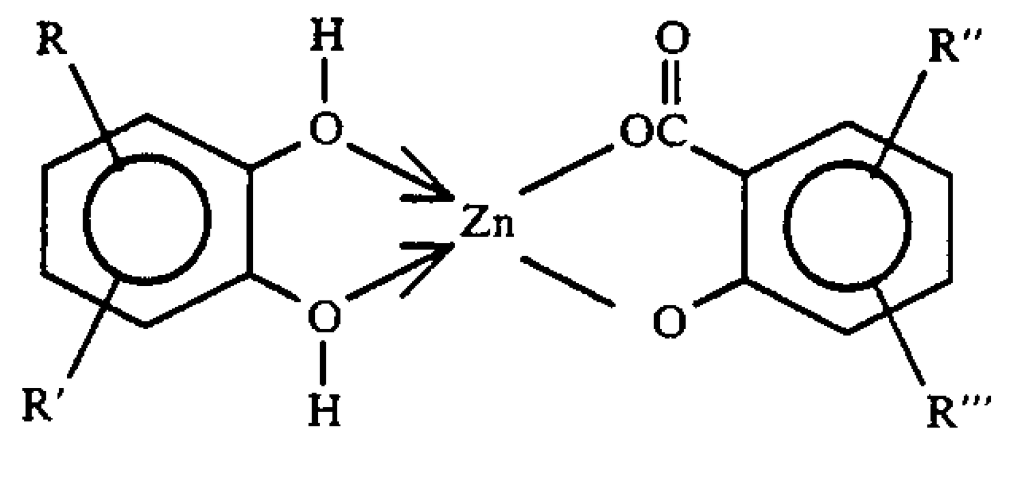


where M is the central metal ion; N+is the counter cation; R and R' are selected from the group consisting of alkyl, alkoxy, aryloxy, halogen, carbonyl group, alkoxycarbonyl group, amino group, nitro group or mixtures thereof; m and n are the number of R substituents on the aromatic rings, ranging from 0 to 3; y—is the magnitude of the negative charge of the anion or the number of the counter cations of the metal complex, and represents the number 1 or 2; and y' represents the number of countercations N+; U.S. patent application Ser. No. 964,544 is a toner composition comprised of a polymer or polymers, pigment particles and/or dyes, optional surface additives, and a charge enhancing additive of the following formula



wherein R is hydrogen, alkyl, or aryl, R' and R'' are selected from the group consisting of alkyl, alkoxy, aryl, and aryloxy, R''' is selected from the group consisting of alkyl, alkoxy, oxide, and halide, M is boron or a metal, x is a number of from 1 to 4, and y is a number of from 0 to 2; and U.S. patent application Ser. No. 964,541 is a negatively charged toner composition comprised of polymer, pigment, optional surface additives, and a zinc complex charge enhancing additive represented by either of the two following formulas





wherein R, R', R'', and R''' are independently selected from the group consisting of hydrogen, alkyl, aryl alkoxy, aryloxy, halogen, amino, and hydroxy.

The disclosures of each of the copending applications are totally incorporated herein by reference.

Although many charge enhancing additives are known, there continues to be a need for charge enhancing additives which when selected for toners, provide toners with many of the advantages illustrated herein. There is also a need for economical negative charge enhancing additives which are useful for incorporation into black and colored toner compositions which can be utilized for developing positive electrostatic latent images. Moreover, there is a need for colored toner compositions containing charge enhancing additives which do not interfere with the color quality of the colorants present in the toners. Another need relates to the provision of toner compositions with certain charge enhancing additives, which toners in embodiments thereof possess substantially stable triboelectric charge levels, and display acceptable rates of triboelectric charging characteristics. Furthermore, there is also a need for toner compositions with certain charge enhancing additives which possess excellent dispersibility characteristics in toner resins, and can therefore, form stable dispersions thereof. There is also a need for negatively charged black and colored toner compositions that are useful for incorporation into various imaging processes, inclusive of color xerography, as illustrated in U.S. Pat. No. 4,078,929, the disclosure of which is totally incorporated herein by reference; laser printers; and additionally a need for toner compositions useful in imaging apparatuses having incorporated therein layered photoresponsive imaging members, such as the members illustrated in U.S. Pat. No. 4,265,990, the disclosure of which is totally incorporated herein by reference. Also, there is a need for negatively charged toner compositions which have desirable triboelectric charge levels of, for example, from between about −10 to about −50 microcoulombs per gram, and preferably from about −15 to about −30 microcoulombs per gram, and triboelectric charging rates of less than about 120 seconds, and preferably from about 15 to about 60 seconds as measured by standard charge spectrograph methods when the toners are frictionally charged against suitable carrier particles via conventional roll-milling techniques. There is also a need for nontoxic, substantially nontoxic, or environmentally compatible charge enhancing additives which when incorporated at effective concentrations of, for example, less than 7 weight percent, and preferably less than 4 weight percent into toner compositions provide environmentally acceptable compositions. The concentrations of the charge additives that can be selected for the toner compositions generally range from about 0.05 weight percent to about 10 weight percent, depending on whether the charge additive is utilized as a surface additive or as a dispersion in the bulk of the toner. The effective concentrations of toner in the developer, that is toner and carrier particles, are, for example, from about 0.5 to about 5 weight percent, and preferably from about 1 to about 3 weight percent.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide toner and developer compositions with negative charge enhancing additives.

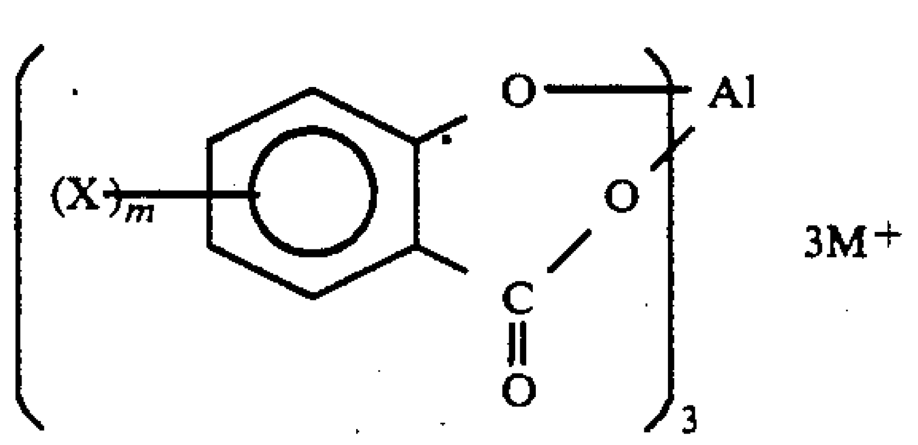
Another object of the present invention is the provision of negatively charged toner compositions useful for the development of electrostatic latent images including color images.

In yet a further object of the present invention there may be provided, it is believed, humidity insensitive, from about, for example, 20 to 80 percent relative humidity at temperatures of from about 60° to 80° F. as determined in a relative humidity testing chamber, negatively charged toner compositions with desirable triboelectric charging rates of less than 120 seconds, and preferably about 30 seconds to about 2 minutes as determined by the charge spectrograph method, and acceptable triboelectric charging levels of from about −10 to about −50 microcoulombs per gram.

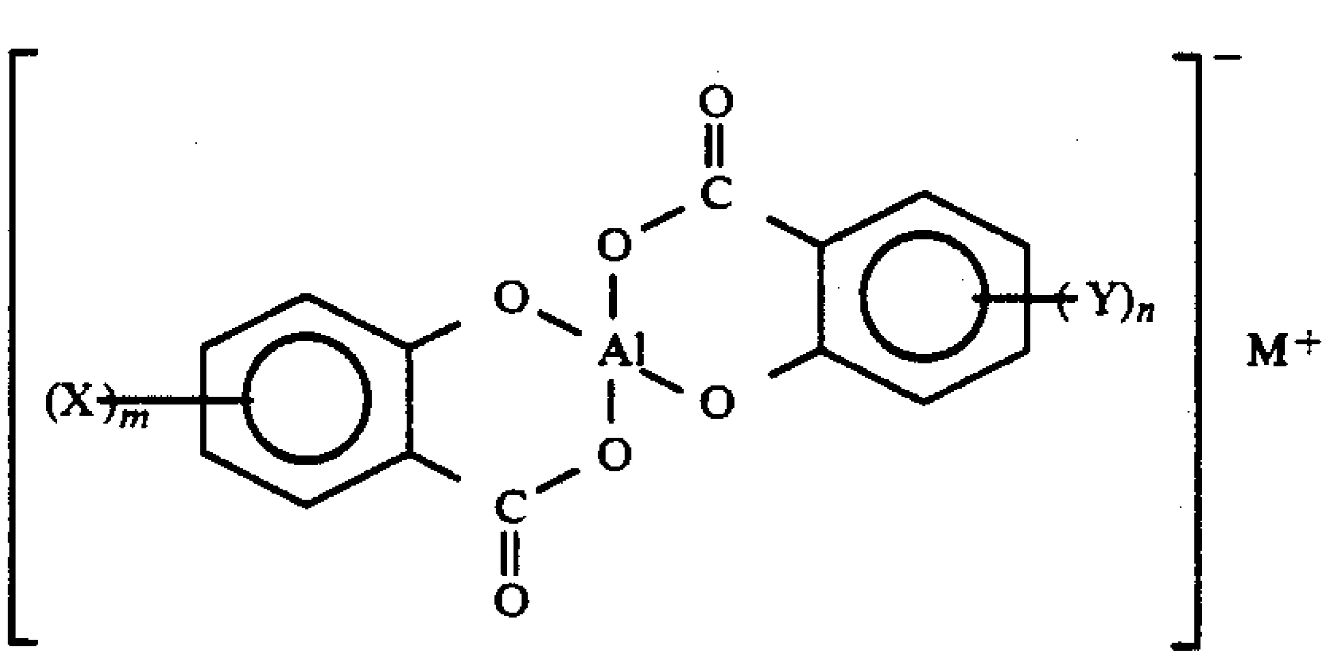
Another object of the present invention resides in the preparation of negatively charged toners which will enable the development of images in electrophotographic Imaging apparatuses, which images have substantially no background deposits thereon, are substantially smudge proof or smudge resistant, and therefore are of excellent resolution; and further, such toner compositions can be selected for high speed electrophotographic apparatuses, that is for example those exceeding 50 copies per minute.

Also, in another object of the present invention there are provided processes for the preparation of the charge additives illustrated herein, and toners thereof with increased triboelectrical characteristics.

These and other objects of the present invention may be accomplished in embodiments thereof by providing toner compositions comprised of polymer resins, colorants comprised of pigment particles or dye molecules, and certain charge additives. More specifically, the present invention in embodiments is directed to toner compositions comprised of resin, pigment, and a negative charge enhancing additive of the formula



or



wherein M is hydrogen, an alkali metal, or an alkaline earth metal such as lithium, calcium, potassium, cesium, magnesium, calcium, barium, NH_4, NR_4, wherein R is alkyl, X and Y are independently selected from the group consisting of halogens from iodide chloride, fluoride, and bromide, and n and m are the numbers 1 or 2.

Examples of alkyl include known substituents such as those with 1 to about 25 carbon atoms, such as methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, and the like.

Examples of specific charge additives include tris(3,5-diiodosalicylato) aluminum, tris(3,5-dlbromosalicylato) aluminum, tris(S-lodosalicylato) aluminum, tris(5-bromosalicylato) aluminum, tris(3,5-dichlorosalicylato) aluminum, or the corresponding salts there of such as the alkali alkaline earth, or ammonium salts, like sodium, potassium, cesium; the corresponding hydrates, and the like.

The aforementioned charge additives can be incorporated into the toner, may be present on the toner surface, or may be present on toner surface additives such as colloidal silica particles. Advantages of rapid triboelectric charging characteristics of generally less than 120 seconds, as measured by the standard charge spectrograph methods when the toners are frictionally charged against carrier particles by known conventional roll mixing methods, appropriate triboelectric charge levels, and the like can be achieved with many of the aforementioned toners of the present invention. In another embodiment of the present invention, there is provided subsequent to known micronization and classification, toner particles with a volume average diameter of from about 4 to about 20 microns.

The halogenated aluminum salicylic acid complexes of the present invention can be prepared, for example, by heating an aluminum salt such as aluminum sulfate with a halogenated salicylic acid, such as 3,5-diilodosalicylic acid and 3,5-dibromosalicylic acid in an aqueous solution at 50° to 1000° C. in the presence of a base, such as NAOH, KOH, and the like. The ratio of the aluminum salt to the salicylic acid can be about 1:10, with 1:4 being preferred. The base is present In an equivalent amount to the halogenated salicylic acid, and the amount of water can be from about 50 milliliters to 300 milliliters per 10 grams of halogenated salicylic acid with 80 to 200 milliliters per 10 grams of halogenated salicylic acid being preferred. The product is filtered by filtration and purified by washing with warm water. Yields can be excellent, ranging from about 80 percent to about 100 percent. The resulting aluminum complex can be characterized by conventional techniques, such as melting point, infrared spectroscopy and elemental analysis. Other charge additive complexes can be prepared in a similar manner.

The toner compositions of the present invention can be prepared by a number of known methods such as admixing and heating polymer resins such as styrene butadiene copolymers, colorants such as color pigment particles or dye compounds, and the aforementioned charge enhancing additive, or mixtures of charge additives in a concentration preferably ranging from about 0.5 percent to about 5 percent in a toner extrusion device, such as the ZSK53 available from Werner Pfleiderer, and removing the resulting toner composition from the device. Subsequent to cooling, the toner composition is subjected to grinding utilizing, for example, a Sturtevant micronizer for the purpose of achieving toner particles with a volume average diameter of from about 4 to about 25 microns, and preferably from about 4 to about 12 microns, which diameters are determined by a Coulter Counter. Subsequently, the toner compositions can be classified utilizing, for example, a Donaldson Model B classifier for the purpose of removing unwanted fine toner particles.

Illustrative examples of suitable toner resins selected for the toner and developer compositions of the present invention include vinyl polymers such as styrene polymers, acrylonitrile polymers, vinyl ether polymers, acrylate and methacrylate polymers; epoxy polymers; polyurethanes; polyamides and polyamides; polyesters; and the like. The polymer resins selected for the toner compositions of the present invention include homopolymers or copolymers of two or more monomers. Furthermore, the above-mentioned polymer resins may also be crosslinked depending on the desired toner properties. Illustrative vinyl monomer units selected for the vinyl polymers include styrene, substituted styrenes such as methyl styrene, chlorostyrene, methyl acrylate and methacrylate, ethyl acrylate and methacrylate, propyl acrylate and methacrylate, butyl acrylate and methacrylate, pentyl acrylate and methacrylate, butadiene, vinyl chloride, acrylonitrile, acrylamide, alkyl vinyl ether and the like. Illustrative examples of the dicarboxylic acid units in the polyester resins suitable for use in the toner compositions of the present invention include phthalic acid, terephthalic acid, isophthalic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, maleic acid, fumaric acid, dimethyl glutaric acid, bromoadipic acids, dichloroglutaric acids, and the like; while illustrative examples of the diol segments in the polyester resins include ethanediol, propanediols, butanediols, pentanediols, pinacol, cyclopentanediols, hydrobenzoin, bis(hydroxyphenyl)alkanes, dihydroxybiphenyl, substituted dihydroxybiphenyls, and the like.

As one toner resin, there are selected polyester resins derived from a dicarboxylic acid and a diphenol. These resins are illustrated in U.S. Pat. No. 3,590,000, the disclosure of which is totally incorporated herein by reference; polyester resins obtained from the reaction of bisphenol A and propylene oxide, followed by the reaction of the resulting product with fumaric acid, and branched polyester resins resulting from the reaction of dimethylterephthalate with 1,3-butanediol, 1,2-propanediol, and pentanetriol. Further, low melting polyesters, especially those prepared by reactive extrusion, reference U.S. patent application Ser. No. 07/814,641 and U.S. Pat. No. 5,227,460, the disclosures of which are totally incorporated herein by reference, can be selected as toner resins. Other specific toner resins include styrene-methacrylate copolymers, and styrene-butadiene copolymers; PLIOLITES®; and suspension polymerized styrene-butadienes, reference U.S. Pat. No. 4,558,108, the disclosure of which is totally incorporated herein by reference. Also, waxes with a molecular weight of from about 1,000 to about 7,000 such as polyethylene, polypropylene, and paraffin waxes can be included in or on the toner compositions as fuser roll release agents.

The toner resin is present in a sufficient, but effective amount, for example from about 30 to about 95 weight percent. Thus, when 2 percent by weight of the charge enhancing additive is present, and 8 percent by weight of colorant, such as carbon black or color pigment, is contained therein, about 90 percent by weight of resin is selected. Also, the charge enhancing additive of the present invention may be applied as a surface coating on the toner particles. When used as a coating, the charge enhancing additive of the present Invention is present in an effective amount of, for example, from about 0.05 weight percent to about 5 weight percent, and preferably from about 0. 1 weight percent to about 1.0 weight percent. Also, in embodiments the charge additive may be admixed with colloidal silica particles and absorbed on the surface thereof, and the resulting product can then be applied to the toner as a surface additive.

Numerous well known suitable color pigments or dyes can be selected as the colorant for the toner compositions including, for example, carbon black, like REGAL 330®, nigrosine dye, metal phthalocyanines, aniline blue, magnetite, or mixtures thereof. The colorant, which is preferably carbon black or other color pigments, should be present in a sufficient amount to render the toner composition with a sufficiently high color intensity. Generally, the colorants are present in amounts of from about 1 weight percent to about 20 weight percent, and preferably from about 2 to about 10 weight percent based on the total weight of the toner composition; however, lesser or greater amounts of colorant can be selected.

When the colorants are comprised of magnetites or a mixture of magnetites and color pigment particles, thereby enabling single component toners and toners for magnetic ink character recognition (MICR) applications in some instances, which magnetites are a mixture of iron oxides (FeO-Fe_2O_3) including those commercially available as MAPICO BLACK®, they are present in the toner composition in an amount of from about 5 weight percent to about 70 weight percent, and preferably in an amount of from about 10 weight percent to about 50 weight percent. Mixtures of carbon black and magnetite with from about 1 to about 15 weight percent of carbon black, and preferably from about 2 to about 6 weight percent of carbon black, and magnetite, such as MAPICO BLACKO, in an amount of, for example, from about 5 to about 70, and preferably from about 10 to about 50 weight percent can be selected for black toner compositions of the present invention.

There can also be blended with the toner compositions of the present invention external additives including flow aid additives, which additives are usually present on the surface thereof. Examples of these additives include colloidal silicas such as AEROSIL®, metal salts and metal salts of fatty acids inclusive of zinc stearate, aluminum oxides, cerium oxides, titanium oxides, and mixtures thereof, which additives are generally present in an amount of from about 0.1 percent by weight to about 5 percent by weight, and preferably in an amount of from about 0.5 percent by weight to about 2 percent by weight. Several of the aforementioned additives are illustrated in U.S. Pat. Nos. 3,590,000 and 3,800,588, the disclosures of which are totally incorporated herein by reference.

With further respect to the present invention, colloidal silicas such as AEROSIL® can be surface treated by known means like fluidized bed spray methods, solution coating, and the like, with the charge additives of the present invention illustrated herein in an amount of from about 1 to about 50 weight percent and preferably 10 weight percent to about 25 weight percent followed by the addition thereof to the toners in an amount of from 0.1 to 10 and preferably 0.1 to 5 weight percent.

Also, there can be included in the toner compositions of the present invention low molecular weight waxes, such as polypropylenes and polyethylenes commercially available from Allied Chemical and Petrolite Corporation, EPOLENE N-15 TM commercially available from Eastman Chemical Products, Inc., VISCOL 550-P TM, a low weight average molecular weight polypropylene available from Sanyo Kasei K. K., and similar materials. The commercially available polyethylenes selected have a molecular weight of from about

1,000 to about 1,500, while the commercially available polypropylenes utilized for the toner compositions of the present invention are believed to have a molecular weight of from about 4,000 to about 5,000. Many of the polyethylene and polypropylene compositions useful in the present invention are illustrated in British Patent No. 1,442,835, the disclosure of which is totally incorporated herein by reference. These low molecular weight wax materials are present in the toner composition of the present invention in various amounts, however, generally these waxes are present in the toner composition in an amount of from about 1 percent by weight to about 15 percent by weight, and preferably in an amount of from about 2 weight percent to about 10 weight percent.

Encompassed within the scope of the present invention are colored toner and developer compositions comprised of toner resins, optional carrier particles, the charge enhancing additives illustrated herein, and as colorants black, red, blue, green, brown, magenta, cyan and/or yellow dyes and mixtures thereof. More specifically, with regard to the generation of color images utilizing a developer composition with the charge enhancing additives of the present invention, illustrative examples of magenta materials that may be selected as colorants include, for example, 2,9-dimethyl-substituted quinacridone and anthraquinone dye identified in the Color Index as Cl 60710, Cl Dispersed Red 15, diazo dye identified in the Color Index as Cl 26050, Cl Solvent Red 19, and the like. Illustrative examples of cyan materials that may be used as colorants include copper phthalocyanine, x-copper phthalocyanine pigment listed in the Color Index as Cl 74160, Ci Pigment Blue, and Anthrathrene Blue, identified in the Color Index as Cl 69810, Special Blue X-2137, and the like; while illustrative examples of yellow pigments that may be selected are diarylide yellow 3,3-dlchlorobenzidene acetoacetanilides, a monoazo pigment identified in the Color Index as Cl 12700, Cl Solvent Yellow 16, a nitrophenyl amine sulfonamide identified in the Color Index as Foron Yellow SE/GLN, Cl Dispersed Yellow 33, 2,5-dimethoxy-4-sulfonanilide phenylazo-4'-chloro-2,5-dimethoxy acetoacetanilide, and Permanent Yellow FGL. The aforementioned colorants are incorporated into the toner composition in various suitable effective amounts providing the objectives of the present invention are achieved, in embodiments, these colorants are present in the toner composition in an amount of from about 1 percent by weight to about 15 percent by weight based on the total weight of the toner.

For the formulation of developer compositions, there are mixed with the toner particles carrier components, particularly those that are capable of triboelectrically assuming an opposite polarity to that of the toner composition. Accordingly, the carrier particles of the present invention are selected to be those that would render the toner particles negatively charged while acquiring a positive charge polarity via frictional charging against the toner particles of the present invention. The opposite charge polarities of the carrier and toner particles of the developer composition thus ensure the toner particles adhere to and surround the carrier particles. Illustrative examples of carrier particles include iron powder, steel, nickel, iron, ferrites, including copper zinc ferrites, nickel zinc ferrites, and the like. Additionally, there can be selected as carrier particles nickel berry carriers as illustrated in U.S. Pat. No. 3,847,604, the disclosure of which is totally incorporated herein by reference. The selected carrier particles can be used with or without a coating, the coating generally containing terpolymers of styrene, methylmethacrylate, and a silane, such as triethoxysilane, reference U.S. Pat. Nos. 3,526,533 and 3,467,634, the disclosures of which are totally incorporated herein by reference; polymethyl methacrylates; other known coatings; and the like. The carrier particles may also include in the coating, which coating can be present in one embodiment in an amount of from about 0.1 to about 3 weight percent, conductive substances such as carbon black in an amount of from about 5 to about 30 percent by weight. Polymer coatings not in close proximity in the triboelectric series can also be selected, reference U.S. Pat. Nos. 4,937,166 and 4,935,326, the disclosures of which are totally incorporated herein by reference, including for example KYNAR® and polymethylmethacrylate mixtures (40/60). Coating weights can vary as indicated herein; generally, however, from about 0.3 to about 2, and preferably from about 0.5 to about 1.5 weight percent coating weight is selected.

Furthermore, the diameter of the carrier particles, preferably spherical in shape, is generally from about 50 microns to about 1,000, and preferably from between about 80 and 200 microns in volume average diameter thereby permitting them, for example, to possess sufficient density and inertia to avoid adherence to the electrostatic images during the development process. The carrier component can be mixed with the toner composition in various suitable combinations, such as about 1 to 5 parts of toner to about 100 parts to about 200 parts by weight of carrier.

The toner composition of the present invention can be prepared by a number of known methods including extrusion melt blending the toner resins, colorants, and the halogenated aluminum salicylic acid complex charge enhancing additive of the present invention as indicated herein, followed by mechanical attrition and classification. Other methods include those well known in the art such as spray drying, melt dispersion, extrusion processing, dispersion polymerization, and suspension polymerization. Also, as indicated herein the toner composition without the charge enhancing additive can be first prepared, followed by addition of the charge enhancing additive and other optional surface additives, or the charge enhancing additive-treated surface additive such as colloidal silicas. Further, other methods of preparation for the toner are as illustrated herein.

The toner and developer compositions of the present invention may be selected for use in electrostatographic imaging and printing apparatuses containing therein conventional photoreceptors providing that they are capable of forming positive electrostatic latent images relative to the triboelectric charge polarity of the toners.

The toners of the present invention are usually jetted and classified subsequent to preparation to enable toner particles with a preferred volume average diameter of from about 4 to about 25 microns, and more preferably from about 4 to about 12 microns. The triboelectric charging rates for the toners of the present invention are in embodiments less than 120 seconds, and more specifically, from about 30 seconds to 2 minutes as determined by the known charge spectrograph method as described hereinbefore. These toner compositions with rapid rates of triboelectric charging characteristics enable, for example, the development of images in electrophotographic Imaging apparatuses, which images have substantially no background deposits thereon, even at high toner dispensing rates in some instances, for instance exceeding 30 grams per minute; and further, such toner compositions can be selected for high speed electrophotographic apparatuses, that is those exceeding 50 copies per minute.

The following Examples are being supplied to further illustrate various embodiments of the present invention, it being noted that these Examples are intended to illustrate and not limit the scope of the present invention. Comparative Examples are also presented.

EXAMPLE I

Synthesis of Aluminum3,5-Diiodosalicylic Acid Complex

An aqueous solution of aluminum sulfate comprised of 41.7 grams of $Al_2(SO_4)_3.18H_2O$ in about 400 milliliters of water was added over a period of 20 minutes to a warm (about 700° C.) solution containing 97.5 grams of 3,5-diiodosalicylic acid and 10.5 grams of sodium hydroxide in 1 liter of water. A white precipitate was formed immediately. The mixture was then heated to about 90° C. and stirred for another three hours. It was then cooled to room temperature, about 25° C., and the white solid product was isolated by filtration to yield a crude product of about 110 grams. The crude product was purified by washing with warm water (twice, 1 liter each) and ether (once, 1 liter), affording pure, no impurities detected, tris aluminum 3,5-diiodosalicylic acid trihydrate complex or tris(3,5-diiodosalicylato) aluminum, 103.3 grams (99 percent yield).

m.p.:>2600° C.

IR(KBr): 1,572 and about 1,630 cm^{-1}.

Calculated for $C_{21}H_{15}O_{12}I_6A_l$: C20.2, H 1.2, 161.0, A12.2; Found: C20.2, H1.1, 159.9, A12.5.

EXAMPLE II

Synthesis of Aluminum 3,5-Dibromosalicylic Acid Complex

The pure charge control additive, aluminum 3,5-dibromosalicylic acid trihydrate complex or tris(3,5-dlbromosalicylato) aluminum hydrate complex, was prepared by repeating the process of Example I. Yield was 82 percent.

m.p.:>3100° C.

IR(KBr): 1,580 and about 1,620 cm^{-1}.

Calculated for $C_{21}H_{15}O_{12}Br_6Al$: C26.1, H1.5, Br49.6, A12.8; Found: C 25.5, H 1.2, Br 49.5, AC 2.7.

EXAMPLE III

There were prepared toners with the negative charge additive of Example I, that is the aluminum 3,5-diiodosalicylic acid complex. The charge additive, 0.3 gram, was dispersed in about 100 milliliters of diisopropylether in a 250 milliliter round bottom flask. AEROSIL R972 ® obtained from Degussa (3.0 grams) was added and the resulting suspension was stirred for 0.5 hour. The ether solvent was then evaporated on a rotary evaporator. The residue obtained was transferred to a crystallization dish where it was dried in an oven overnight, about 20 hours, at 120° C. The solid was then transferred to a 4 ounce bottle and roll milled with 35 grams of ¼ inch steel shot for 30 minutes at a speed of 90 feet/minute, yielding 3 grams of a fluffy white powder comprised of 10 percent by weight of the aluminum 3,5-diiodosalicylic acid (1:3) complex and 90 percent of AEROSIL R9721 ®. The formed white powder charge additive composite, 0.063 gram, was then added to 12.5 grams of (1) styrene butadiene, 91/9, and (2) SPAR 11 ® polyester toner in two separate 4 ounce bottles each containing 125 grams of steel shot of ¼ inch diameter and the bottles were then roll milled for 30 minutes.

Developer compositions were then prepared by adding 1.25 grams of the above toners and 60 grams of a steel core carrier, 130 microns in diameter and 0.8 percent by weight of a surface coating of polymethylmethacrylate (PMMA) with 20 percent carbon black, and then roll milled for 60 minutes at a speed of 90 feet/minute to generate the time zero developers. The tribos and the admix times were evaluated by the known Faraday Cage method and the charge spectrograph technique, respectively. The results were as follows:

TONER RESIN	TRIBO Microcoulombs/gram	ADMIX
Styrene Butadiene (91/9)	−49.7	2 minutes
SPAR II ®-Polyester	−20.6	1 minute

EXAMPLE IV

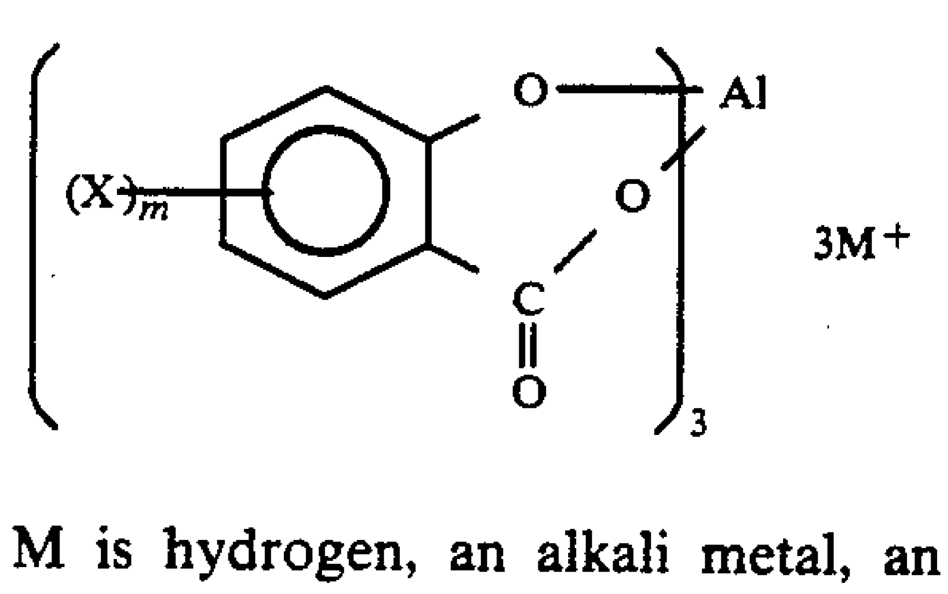
Toners and developers were prepared from the negative charge additive synthesized in Example 11, the aluminum 3,5-dibromosalicylic acid complex, using the procedures described in Example Ill. The results were as follows:

TONER RESIN	TRIBO Microcoulombs/gram	ADMIX
Styrene Butadiene (91/9)	−36.3	2 minutes
SPAR II ®-Polyester	−19.3	1 minute

Other modifications of the present invention may occur to those skilled in the art subsequent to a review of the present application, and these modifications, including equivalents thereof, are intended to be included within the scope of the present invention.

What is claimed is:

1. A negatively charged toner composition comprised of resin particles, pigment particles, optional surface additives, and a halogenated aluminum salicylic acid complex charge enhancing additive of the following formula



wherein M is hydrogen, an alkali metal, an alkaline earth metal, NH_4, or NR_4; X is independently selected from the group consisting of iodide, chloride and bromide, and m is the number 1 or 2.

2. A toner composition in accordance with claim **1** wherein M, is selected from the group consisting of hydrogen, lithium, sodium, potassium, cesium, magnesium, calcium, barium, and NR_4 wherein R is methyl.

3. A toner composition in accordance with claim 1 wherein X is iodide or bromide.

4. A toner composition in accordance with claim 1 wherein the charge additive is present in an amount of from about 0.05 to about 5 weight percent.

5. A toner composition in accordance with claim 1 wherein the charge additive is present in an amount of from about 0.1 to about 3 weight percent.

6. A toner composition in accordance with claim 1 wherein the charge additive is incorporated into the toner.

7. A toner composition in accordance with claim 1 wherein the charge additive is present on the surface of the toner composition.

8. A toner composition in accordance with claim 7 wherein the charge additive is contained on colloidal silica particles, or titanium dioxide particles.

9. A toner composition in accordance with claim 1 wherein the toner's rate of charging is from about 15 seconds to about 120 seconds by frictional charging against suitable carrier particles.

10. A toner composition in accordance with claim 1 with a negative triboelectric charge of from between about −10 to about −50 microcoulombs per gram.

11. A toner composition in accordance with claim 1 wherein the resin particles are selected from the group consisting of styrene acrylates, styrene methacrylates, styrene butadienes, and polyesters.

12. A toner composition in accordance with claim 1 containing a wax component which has a weight average molecular weight of from about 1,000 to about 6,000.

13. A toner composition in accordance with claim 12 wherein the wax component is selected from the group consisting of polyethylene and polypropylene.

14. A toner composition in accordance with claim 1 wherein surface additives of metal salts of a fatty acid, colloidal silicas, titanium dioxide, tin oxide, or mixtures thereof are added to said toner.

15. A toner composition in accordance with claim 1 wherein the pigment particles are carbon black, magnetites, or mixtures thereof, cyan, magenta, yellow, red, blue, green, brown or mixtures thereof.

16. A developer composition comprised of the toner composition of claim 1 and carrier particles.

17. A developer composition in accordance with claim 16 wherein the carrier particles are selected from the group consisting of ferrites, steel, and an iron powder with a polymer or mixture of polymers coating thereover.

18. A developer composition in accordance with claim 16 wherein the coating is selected from the group consisting of a methyl terpolymer, a polyvinylidine fluoride, a polymethyl methacrylate, and a mixture of polymers not in close proximity in the triboelectric series.

19. A toner composition in accordance with claim 1 wherein the charge additive is tris(3,5-diiodosalicylato) aluminum, tris(3,5-dibromosalicylato) aluminum, tris(5-iodosalicylato) aluminum, tris(5-bromosalicylato) aluminum, tris(3,5-dichlorosalicylato) aluminum, or their corresponding alkali, alkaline earth or ammonium salts thereof.

20. A toner composition in accordance with claim 11 wherein the charge additive is tris(3,5-diidosalicylato) aluminum, tris(3,5-dibromosalicylato) aluminum, tris(5-iodosalicylato) aluminum, tris(5-bromosalicylato) aluminum, tris(3,5-dichlorosalicylato) aluminum, or their corresponding alkali, alkaline earth or ammonium salts thereof.

* * * * *